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ABSTRACT

This trainer's manual is designed to assist nursing instructors assigned to advanced medical surgical nursing courses in teaching students how to make basic interpretations of their patients' electrocardiographic (EKG) strips. Included in the manual are pre- and posttests and instructional units dealing with the following topics: EKG indicators, EKG ruled paper divisions, the normal cardiac cycle and pathophysiology, abnormal cardiac waves, atrial and ventricular rhythmycity, EKG heart rate determinations, and analysis of EKG strips. Each unit contains some or all of the following: an outline summary of critical content, answers to the corresponding review questions and practice exercise contained in a separately available student workbook, classroom discussion questions, and sample responses. A list of suggested references concludes the guide. (MN)

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# EKG INTERPRETATION PROGRAM

## TRAINERS MANUAL

Sandra M. Webb

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## INTRODUCTION

"The EKG Program" for advanced medical surgical nursing students in the intensive care unit (ICU) is intended to equip nursing students with the necessary skills to make basic interpretations of their clients electrocardiographic (EKG) strips.

The trainers manual was, therefore, developed for the nursing instructor presenting the program. The manual provides the teaching strategies and approaches to be used during the implementation of the program.

Consequently the trainers manual should be used in combination with the design document, student workbook and the required/recommended textbooks.

## ORGANIZATION OF THE TRAINERS MANUAL

The trainers manual consists of nine sections: two section (an Introduction and Conclusion) containing the pre-instructional and post-instructional examination; and seven sections dealing with instructional material, each section corresponding with a

design document learner objective and student workbook section. Each of the seven instructional sections (excluding the pre-test and the post-test) has been further divided to include the following four components: Summary of Critical Content; Workbook Answers, Classroom Discussion Questions and Sample Responses.

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## SECTION I

Summary of Critical Content

I. Indications for an EKG
   - A. Cardiac
     1. Ischemia
     2. Injury
     3. Infarction
     4. Irregular Pulse Rate
     5. Hypertrophy
     6. Enzyme Elevation
        a. SGOT
        b. SGPT
        c. LDH
        d. CPK
     7. Symptomatology
        a. Shortness of Breath (S.O.B.)
        b. Chest Pains
   - B. Metabolic
     1. Metabolic Acidosis
     2. Respiratory Acidosis
     3. Respiratory Alkalosis
     4. Metabolic Alkalosis
     5. Electrolyte Disturbance
        a. K+ (Potassium)
        b. Ca++ (Calcium)
   - C. Inflammation
     1. Cardiac
     2. Respiratory
   - D. Pharmacologic Agents
     1. Antiarrthymics
        a. Digoxin
        b. Quinidine
        c. Inderal
     2. Bronchodilators
     3. Anesthetics
     4. Psychotherapeutics
     5. Catecholamines

## WORKBOOK ANSWERS

### Review Questions

1. Cardiac, Metabolic, Pharmacological and Inflammatory.
2. An EKG is indicated in an MI client because of ischemia, infarction and injury of the heart musculature.
3. An EKG is indicated in a C.H.F. client because of hypertrophy.
4. The client has an arrthymia.
5. The client is on an antiarrthymic med.

### Practice Exercise

| Classification | | Condition |
|---|---|---|
| Cardiac | - | M. I.<br>C. H. F. |
| Inflammation | - | Pneumonia |
| Metabolic | - | Respiratory Acidosis<br>Hypokalemia<br>Hypocalcemia |
| Pharmacological | - | Catecholamine<br>Anesthetic |

## CLASSROOM DISCUSSION QUESTIONS

| | Sample Responses |
|---|---|
| 1. Can you think of some bronchodilators that nurses frequently give patients, which might also create cardiac problems requiring an EKG? | 1. Aminophylline<br>Theophylline<br>Dyphylline (dilor)<br>Oxytriphylline (choledyl) |
| 2. What about psychotherapeutics ...? | 2. Stelazine<br>Mellaril<br>Sparine<br>Haldol (minimal cardiac effect if within (w/i) therapeutic dosage<br>Thorazine |

3. Review definition of terminology:

| | |
|---|---|
| Infarction | Area of necrosis |
| Injury | Damage or pathology |
| Ischemia | Decrease blood supply |
| Hypertrophy | Enlarged |

## SECTION II

### Summary Critical Content

I. EKG Graph Paper
   - A. Horizontal Axis = Time
   - B. Vertical Axis = Voltage
   - C. Divisions
     1. Large Square
        - a. Vertical Axis = 5 mm = 0.5 mv
        - b. Horizontal Axis = 5 mm = .20 seconds
        - c. Composition = 25 small boxes
     2. Small Square
        - a. Vertical Axis = 1 mm = 0.1 mv
        - b. Horizontal Axis = 1 mm = .04 seconds
     3. Marginal Markings = 3 seconds

### Workbook Answers

1. The space between 15 large squares equals a 3 second interval (15 x .20 seconds = 3 seconds).

2. 10 mm = 1.0 mv of energy.

| Classroom Discussion | Sample Response |
|---|---|
| What is the significance of making duration and amplititude assessments? | These assessments help to confirm or disprove cardiac pathology. |
| Review definition of terminology: | |
| Mullimeter | 1/1000th of a meter |
| Mullivolt | 1/1000 of a volt |
| Voltage | Unit of force (electromotive) |

## SECTION III

Summary of Critical Content

I. "P" Wave
   - A. Wave characteristics = upright, rounded
   - B. Location in cycle - first EKG component
   - C. Height/Depth = 0.3 - 2.0 mm
   - D. Duration = 0.05 sec to 0.12 sec
   - E. Pathophysiology = Atrial Depolarization

II. "P-R" Interval
   - A. Interval characteristics - beginning of P wave til beginning of Q wave
   - B. Location in cycle = second EKG component
   - C. Duration = 0.12 secs to 0.20 secs
   - D. Pathophysiology = AV Node (1/10 sec. pause)

III. "QRS" Complex
   - A. Wave characteristics
     1. "Q" Wave - downward deflection (negative)
     2. "R" Wave - upward deflection (positive)
     3. "S" Wave - downward deflection (negative)
   - B. Location
     1. "W" Wave - the first downward deflection, occurs after P-R interval and before "R" wave
     2. "R" Wave - the first upward deflection, occurs after P-R interval and before "S" wave
     3. "S" Wave - the first negative deflection, occurs after the "R" wave and before "T" wave
   - C. Height/Depth
     1. "Q" Wave < 5 mm (< 1/3 of entire QRS complex)
     2. "R" Wave > 5 mm
     3. "S" Wave < 5 mm
   - D. Duration
     1. "Q" Wave < 0.04 secs
     2. Entire "QRS" complex = 0.11 sec duration
   - E. Pathophysiology = Ventricular Depolarization

IV. "T" Wave
   - A. Wave characteristic - upright, rounded
   - B. Location in cycle - after "QRS" complex
   - C. Height/Depth = 1.0 to 5.0 mm
   - D. Pathophysiology - Ventricular Repolarization

V. "Q-T" Interval
   A. Interval characteristic = beginning of Q til end of T wave
   B. Duration = 0.32 - 0.43 secs
   C. Pathophysiology = Ventricular systole

VI. "S-T" Segment
   A. Segment characteristic - period between the "QRS" complex and T wave
   B. Height/Depth = EKG baseline
   C. Pathophysiology = period of ventricular depolarization to ventricular repolarization

V. Electrolyte Imbalances
   A. "U" Wave
      1. Wave characteristic - looks like a "u"
      2. Location in cycle - after "T" wave
      3. Pathophysiology - associated with hypokalemia (low potassium level)
   B. "Q-T" Interval
      1. Interval characteristics
         a. Shortened
         b. Prolonged
      2. Duration
         a. Shortened "Q-T" interval < 0.32 secs
         b. Prolonged "Q-T" interval > 0.43 secs
      3. Pathophysiology - associated with calcium (Ca++)
         - shortened "Q-T" = hypercalcemia (↑ Ca++)
         - prolonged "Q-T" = hypocalcemia (↓ Ca++)

Workbook Answers

(Inform students that the identification of each of the waves, intervals and segments will be done during the classroom discussion.

2. a. There are no "Q" waves in this strip.
   b. "R" waves range from 0.4 mv to 0.6 mv
   c. "S" waves range from 0.2 mv to 0.4 mv

3. a. "P" waves = .08 secs
   b. "QRS" complex = .08 secs

| Classroom Discussion | Sample Responses |
|---|---|
| Have the entire class identify the EKG components. (You will need to make a transparency of the strip). | Same as Workbook Answers. |
| Review the calculation made for Questions 2 and 3 of the Workbook Assignment. | Same as Workbook Answers. |
| Ask students to identify the "Q-T" and "P-R" intervals as well as the ST segments. Now ask them to assess the duration of each of these components. | Q-T = 0.32 seconds<br>P-R = 0.16 seconds<br>ST = Is not a measurement of time, it is a measurement of amplitude; amplititude ranges from the baseline to 0.1 mv (1 mm) above the baseline. |

Review Definition of Terminology

| | |
|---|---|
| Segment | A section or portion of the EKG strip |
| Interval | A specific period of time |
| Wave | Movement of electrical energy |
| Complex | Series of events |
| Deflection | Downslope |
| Systole | Normal heart contraction |
| Repolarization | Stimulation of electrical charge |
| Depolarization | Neutralization of the electrical charge |

## SECTION IV

### Summary of Critical Content

I. Inverted "P" wave
   - A. Wave characteristic - opposite/reverse "P" wave
   - B. Pathophysiology - abnormal atrial contraction

II. Widened/Distorted "QRS" complex
   - A. Wave characteristic - bizzarre appearance
   - B. Height/Depth - "Q" wave > 1/3 of entire "QRS" complex
   - C. Duration - "Q" > 0.04 secs
   - D. Pathophysiology - abnormal ventricular depolarization due to myocardial damage

III. Inverted "T" wave
   - A. Wave characteristic - same as inverted "P" wave
   - B. Pathophysiology - abnormal ventricular repolarization due to myocardial damage

IV. S-T Segment Abnormality
   - A. Segment characteristics (abnormal)
     1. Elevation = above EKG baseline
     2. Depression = below EKG baseline
   - B. Pathophysiology
     1. S-T Elevation = acute myocardial injury and anterior myocardial infarction if abnormal "Q" waves present
     2. S-T Depression = posterior myocardial infarction if "R" waves > 5 mm in height are present. (It is also associated with digitalis administration and coronary ischemia).

### Workbook Answers

1. a. Abnormal "P" waves and no distinguishable "T" waves - Atrial Pathology

2. Inverted "P" waves - Atrial Pathology

| Classroom Discussion | Sample Response |
|---|---|
| Can you name the EKG components that signal pathology related to ventricular depolarization? | Q, R, and S Waves |
| Ventricular Repolarization | T Waves |
| Ventricular Systole | Q-T Interval |

Review Definition of Terminology

| | |
|---|---|
| Baseline | Refers to the plane |

## SECTION V

### Summary of Critical Content

I. Importance of Rhythmicity Determinations
   - A. Normal Sinus Rhythm (NSR)
     1. Constant distance between similar waves
     2. Regular rhythm
     3. Identical "P" waves
   - B. Arrthymias
     1. Slow Rates
        - a. Sino-atrial (SA) Block
        - b. Atrio-ventricular (AV) Block
        - c. Bundle-Branch-Block (BBB)
     2. Rapid Rates
        - a. Atrial
          1. Paroxysmal Atrial Tachycardia (PAT)
          2. Atrial Flutter
          3. Atrial Fibrillation
        - b. Ventricles
          1. Paroxysmal Ventricular Tachycardia (run of P.V.C.'s)
          2. Ventricular Flutter
          3. Ventricular Fibrillation
     3. Extra/Skipped Beats
        - a. Atrial (abnormal and early appearing "P" wave)
        - b. A-V Node (normal WRS but is early with no "P" wave)
        - c. Premature ventricular Contraction (P.V.C.)
   - C. Escape Beats

II. Determinations of Cardiac Rhythmicity
   - A. Paper and pencil
   - B. Caliper

### Workbook Answers

1. Irregular "R" Wave Rhythms (variable)

2. Regular "P" Wave

| Classroom Discussion | Samples Responses |
| --- | --- |
| (Review the two Determinations of Rhythmicity Techniques). Ask students to name arrthymia associated with the R wave | Arrthymia related to ventricular activity require evaluations of the entire "QRS" complex which include the "R" wave. These arrthymias are: Ventricular Tachycardias, Flutter, Fiband P.V.C.'s. |
| and the P wave | Extra Atrial Beats<br>PAT<br>Atrial Flutter and Fib |

Review definition of Terminology

Caliper — EKG measurement instrument

## SECTION VI

Summary of Critical Content

I. Heart Rate Determinations based on the E.K.G.
   A. Rules of triplicate

| 300 | 150 | 100 | 75 | 60 | 50 | 43 | 37 | 33 |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

   B. "R" Waves - (large square and small square)
   C. "P" Waves - (small square)

II. Normal Heart (pulse) rate range

III. Abnormal Heart (pulse) rate range

IV. Correlation between symptomatology and pulse rate

Workbook Answers

A. $300 \div 1 = 150$

B. $11 \times 10 = 121$

C. $1500 \div 5 = 300$

Classroom Dicussion

(Review the Methodology for determining each of the Workbook Answers).

Sample Response

Same as Workbook Answers.

Review definition of Terminology:

| | |
|---|---|
| Ventricular Pulse Rate | Beats per minute the ventricles are firing |
| Atrial Pulse Rate | Number of beats per minute the atrias are firing |

## SECTION VII

### Summary of Critical Content

I. Review
   - A. EKG Indications
   - B. EKG Ruled Divisions
   - C. Normal Cardiac Cycle and Pathophysiology
   - D. Abnormal Cardiac Cycle and Pathophysiology
   - E. Cardiac Rhythms
   - F. Cardiac Rates

### Workbook Answers

Section V - (See Section V Trainer's Manual for Rhythmicity determinations).

Ventricular Rate = 100
Apical Rate = 107
P Wave = .04 secs
QRS = .08 secs
PR Interval = .12 secs
ST Segment = 0.1 mv above baseline

Section VI - (See Section VI Trainer's Manual for Cardiac Rate determiations).

Ventricular Rhythm = variable
Atrial Rhythm = regular
P waves = Abnormal dicrotic notch .08 to .12 secs
QRS = .04 secs (no Q waves)
P-R Interval = indistinguishable
Q-T Interval = indistinguishable (can not discern T waves)
S-T Segment = indistinguishable

### Classroom Discussion

(Elicit students feelings or sense of confidence in these determinations. If students feel confident proceed with Post-Test. If students feel shaky wait 1-2 days before giving Post-Test and allow students an opportunity to meet with Instructor individually).

## POST-TEST

1. Depolarization of the heart is characterized by the inflow of which of the following electrolytes:

   a. Na+
   b. K+
   c. Ca++
   d. Mg++
   e. None of the above

2. Repolarization of the heart is characterized by the inflow of which of the following electrolytes:

   a. Na+
   b. K+
   c. Ca++
   d. Mg++
   e. None of the above

3. Contraction of the atrias creates which of the following formations:

   a. P Wave
   b. QRS Wave
   c. Q-T Interval
   d. S-T Segment
   e. T Wave

4. Contraction of the ventricles produces which of the following formations:

   a. P Wave
   b. QRS Wave
   c. Q-T Interval
   d. S-T Segment
   e. T Wave

5. Mr. Jones is 7 hours post MI. Which of the following EKG alterations can be expected?

a. Inverted P waves
b. Inverted T waves
c. No Q waves
d. All of the above
e. None of the above

6. Which of the following enzymes would reflect an elevation 7 hours post MI?

a. CPK
b. SGOT
c. LDH
d. All of the above
e. None of the above

DIRECTIONS: The next four questions (Nos. 7-10) refer to the EKG strips below. You are to interpret each of the strips for the following:

1. Heart rate, i.e., atrial and ventricular
2. Rhythm, i.e., atrial and ventricular
3. P wave
4. QRS wave complex
5. T wave

7.

5. Mr. Jones is 7 hours post MI. Which of the following EKG alterations can be expected?

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c. No Q waves
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e. None of the above

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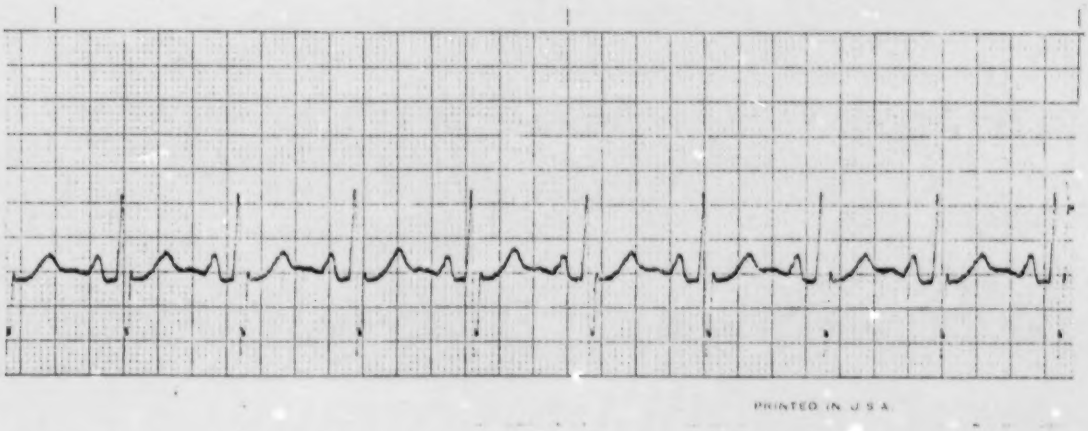
7.



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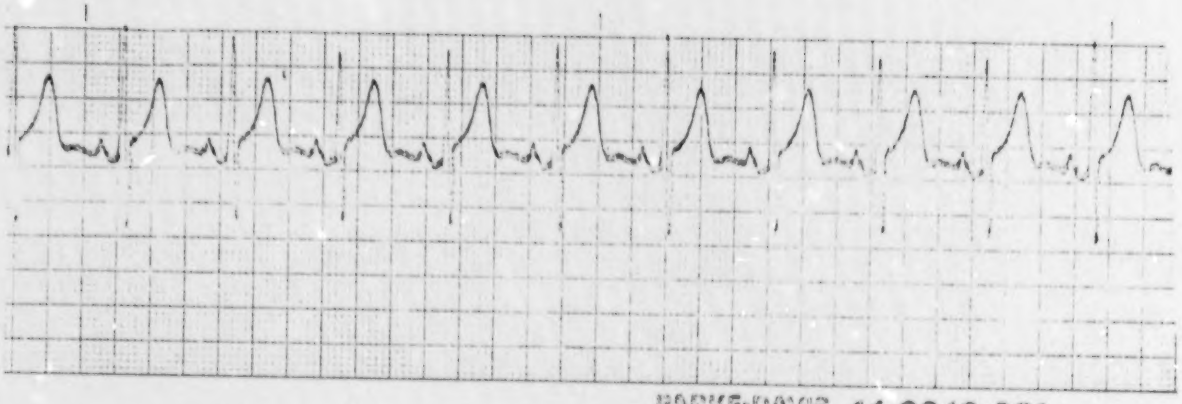


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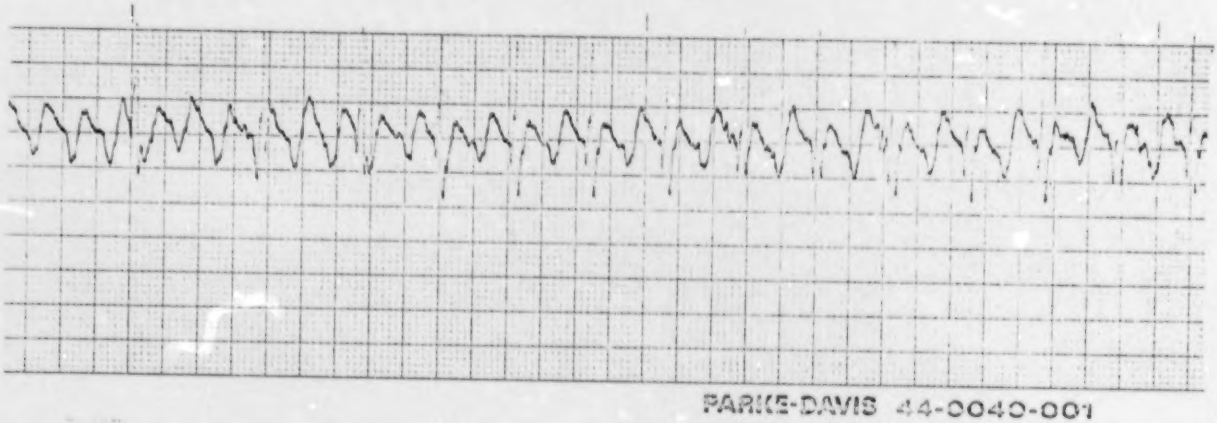


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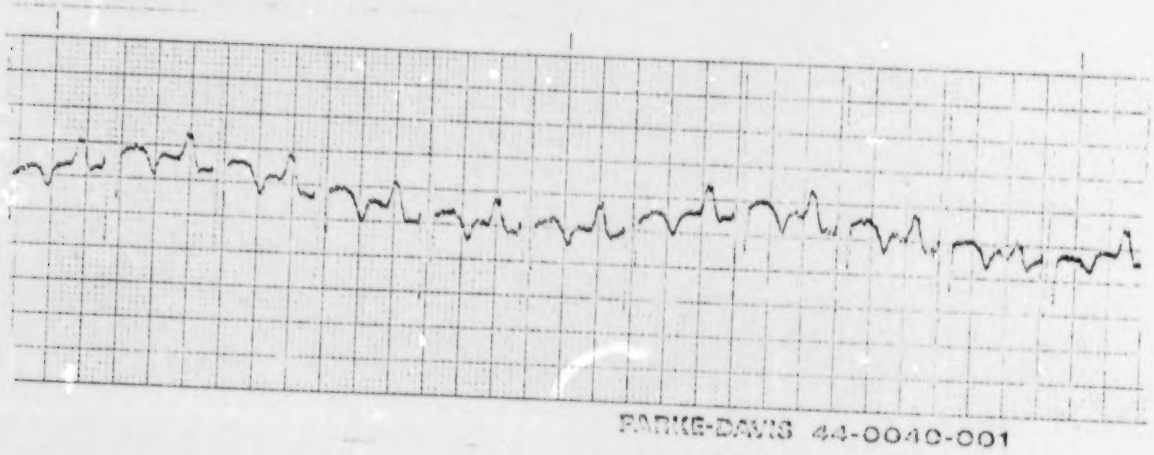




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## POST-TEST ANSWERS

1. a.

2. b.

3. a.

4. b.

5. e.

6. a.

7. Ventricular pulse = 90
   Atrial pulse = 100
   Regular rhythm (atrial and ventricular)
   P waves = .08 seconds
   QRS = .08 seconds
   T waves are normal

8. Ventricular pulse = 100
   Atrial pulse = 100
   Regular rhythm (atrial and ventricular)
   P waves = .04 seconds
   QRS = .08 seconds
   T waves abnormal

9. Ventricular pulse = 75-100
   Atrial pulse = 300
   Rhythm ventricular = irregular
   Rhythm atrial = normal
   P waves = 0.12 seconds
   QRS = 0.8 seconds
   T waves = Non-distinguishable

10. Ventricular pulse = 100
    Atrial pulse = 115
    Rhythm regular (atrial and ventricular)
    P waves = 0.12 seconds and abnormal
    QRS = .08 seconds with Q waves 2/3 of QRS complex
    T waves = Inverted

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*Dick and Carey Textbook of Instructional Design and Design Document Handout 1984 by Gayle Fankhauser were also used as guidelines.


*Refers to Resources provided during Classroom Discussion.